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Coatings Evaluation Guidance For NRC Review of Generic Letter 2004-02 Supplemental Responses Prepared by the Office of Nuclear Reactor Regulation, Division of Component Integrity

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ENCLOSURE 2

COATINGS EVALUATION GUIDANCE FOR NRC REVIEW OF GENERIC LETTER 2004-02 SUPPLEMENTAL RESPONSES PREPARED BY THE OFFICE OF NUCLEAR REACTOR REGULATION, DIVISION OF COMPONENT INTEGRITY

Purpose:

Provide guidance to NRR staff on what information is needed for a supplemental response to GL 2004-02 in the review area of protective coatings. This document also describes acceptable technical assumptions based on research conducted by the NRC and the industry. Numerous testing efforts have been conducted by both the NRC and the industry to address technical uncertainties in areas such as zone of influence (ZOI), coating debris characteristics, unqualified coating performance, and assessment of qualified coatings. One objective of this guidance is to provide the staff's perspective on each of the currently available test reports. Licensees may provide an interpretation of the test data from one of these reports that varies from the staff perspective. However, adequate technical justification should be provided in the supplemental response to support the licensee's interpretation.

Supplemental Response Content:

As described in the "Content Guide for Generic Letter 2004-02 Supplemental Responses," issued by letter to NEI dated August 15, 2007 (ML071060091), the staff believes that the following broad categories of information should be sufficient for closure of the generic letter:

Provide a summary of on type(s) of coating systems used in containment, e.g., Carboline CZ 11 Inorganic Zinc primer, Ameron 90 epoxy finish coat.

Describe the containment coating condition assessment program.

Describe and provide bases for coatings debris generation assumptions. For example, describe how the quantity of paint debris was determined based on ZOI size for qualified and unqualified coatings.

Describe what debris characteristics were assumed, i.e., chips, particulate, size distribution and provide bases for the assumptions.

Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.

Discuss suction strainer head loss testing performed as it relates to both qualified and unqualified coatings and what surrogate material was used to simulate coatings debris. Provide bases for the choice of surrogates.

The remainder of this guide will address each of the above mentioned areas in greater detail including any testing, that the staff is aware of, that may provide bases for technical assumptions.

Technical Details to be Included:

1) Provide a summary of type(s) of coating systems used in containment.

Supplemental responses should discuss the types of qualified coatings used in containment. This may include several types of coatings and several different manufacturers (e.g., Carboline CZ 11 Inorganic Zinc primer, Ameron 90 epoxy finish coat). Licensees should list all of the qualified coating types used in their containment. The substrate (steel or concrete) upon which each coating type is applied should be provided as well as the quantities of each coating type. Dry film thickness (DFT) for each coating system should also be provided. DFT may come from plant records, manufacturer recommendations, or actual sample measurements on the existing coatings.

Licensees should also list the types of unqualified coatings present inside containment if known. If licensees are taking credit for a reduction of unqualified coating debris based on the Electric Power Research Institute (EPRI) Original Equipment Manufacturers (OEM) coatings testing program, an accurate estimate of the quantities of each coating type and its substrate may be necessary. Further discussion of the staff's perspective on the EPRI OEM coatings tests is provided in the debris generation section of this guidance document.

2) Describe the containment coating condition assessment program.

Licensees should describe their program for monitoring containment coatings. This description should include the frequency, extent, and method of coating assessment. It should also discuss qualification of personnel. A description of how degraded coatings are reported, tracked, remediated, and/or scheduled for future remediation should also be provided.

In a letter dated January 16, 2006, the NRC staff expressed concerns regarding the adequacy of the current industry method for assessment of qualified coatings within containment. The staff specifically questioned the adequacy of visual assessment to verify the condition of qualified coatings. In response to the staff concerns, EPRI sponsored a project (see EPRI Report No. 1014883 July 2007) to collect coating adhesion data for coating systems applied in the containments of operating U.S. nuclear power plants to provide confirmatory support for coating inspection methods that rely upon visual inspection as an initial step. The staff has reviewed this report and determined that it provides adequate supporting evidence that the containment coatings monitoring approach contained in ASTM D5163, as implemented by licensees, and endorsed by USNRC in Regulatory Guide 1.54, Rev.1, and NUREG 1801, Vol. 2, Appendix XI.S8, is valid.

Licensees may reference the EPRI coatings adhesion testing program as confirmation of the validity of their coatings assessment program. In addition, licensees may choose to provide a discussion of other activities in which they have participated in to support their coatings program. Such activities may include the EPRI Coatings Aging Task Group, the EPRI survey of

coating failure operating experience, physical testing performed by the licensee, and plant operating experience with coating performance.

3) Describe coatings debris generation assumptions.

ZOI:

The NRC generic safety evaluation (SE) (ADAMS Accession No. ML043280007) stated that licensees should use a coatings ZOI spherical-equivalent determined by plant-specific analysis, based on experimental data that correlate to plant materials over the range of temperatures and pressures of concern, or 10D (10 pipe diameters.) In response to this conservative position, several industry groups conducted destructive jet impingement testing of qualified coatings in order to reduce the 10D value. The staff positions on the two sets of testing are provided below for licensees who use the reduced ZOI value rather than the default 10D:

- WCAP-16568-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) for DBA-Qualified/Acceptable Coatings:"

  Licensees may use this report as the basis for using a ZOI of 4D or greater for qualified epoxy coatings and a ZOI of 5D or greater for qualified untopcoated inorganic zinc coatings.

- Florida Power & Light (FPL) Tests with supporting calculations performed by Areva:

  Licensees may use this report as the basis for using a ZOI of 4D or greater for qualified epoxy coatings. The reports submitted to the NRC by FPL and AREVA at the time of this guidance do not establish a value for untopcoated inorganic zinc. The untopcoated inorganic zinc that was included in the test data eroded at the distances tested (4D). The testers had not established a ZOI for inorganic zinc other than the data that showed it was some value greater than 4D. Unless other data is provided by the licensee, the ZOI for inorganic zinc should remain the default 10D. Licensees may submit other data such as supplemental FPL/AREVA data or WCAP-16568 data, to justify a reduced ZOI for untopcoated inorganic zinc. Similarly, the data submitted to the NRC indicates that Amercoat-90 epoxy failed the tests at the distances tested. Licensees reducing the ZOI to less than 10D for Amercoat 90 should also provide supplemental data.

  The AREVA calculation (Rept No. 32-5066085-00) recommends a ZOI greater than 3.39D. Independent calculations performed for the NRC, using the AREVA inputs, found the maximum bounding break to be 3.67D. The staff therefore determined that a ZOI of 4D for epoxy coatings would be conservative and acceptable.

Unqualified Coatings:

The NRC generic SE recommends that licensees assume 100 percent failure of unqualified coatings. In response to this position EPRI sponsored testing of Original Equipment Manufacturers (OEM) unqualified coatings (see EPRI Report No 1011753, September 2005). The staff positions on these tests are provided below.

Due to the large variation in coating performance, even in the same coating type, it is not possible to predict generically how an unqualified OEM coating will perform under DBA conditions. That is, licensees should not reduce the failure percentage across the board for all unqualified OEM coatings. Therefore, the tests do not provide a substantive generic case to challenge the NRC guidance that 100 percent of unqualified coatings should be expected to fail during a DBA condition.

Five of the 37 coatings tested, as reported in the EPRI OEM report, showed greater than 80 percent failure, with some as high as 99 percent failure. These coatings included alkyds, moisture-cured urethane, and inorganic zinc rich coatings. Licensees would not be able to demonstrate, based on this report alone, that their coatings would not fail at these high amounts and therefore would not be able to take credit for a reduced amount of unqualified coating debris.

Some coatings did perform much better in the tests. If licensees could determine their specific coating types they may be able to credit a reduction in assumed extent of failure of those types. For example if a licensee had records of its unqualified coatings that showed they were consistent with the specific types of epoxy tested in the EPRI OEM report, that licensee may be able to justify a reduction in the amount of debris. For such a case, the staff would expect the licensee to select a failure percentage that bounds the worst performing sample of that coating type in the test data. Licensees may also be able to demonstrate the performance of their unqualified coatings through plant- and coating-specific testing.

4) Describe what debris characteristics were assumed, i.e., chips, particulate, size distribution and provide bases for the assumptions.

The NRC generic SE addresses two distinct scenarios for formation of a fiber bed on the sump screen surface. For a thin-bed case, the SE states that all coatings debris should be treated as particulate and assumes 100 percent transport to the sump screen. For the case in which no thin bed is formed, the staff's SE states that the coating debris should be sized based on plant-specific analyses for debris generated from within the ZOI and from outside the ZOI, or that a default chip size equivalent to the area of the sump screen openings should be used.

In response to this position, industry testing was conducted to determine actual debris characteristics for coatings subjected to DBA conditions.

Testing conducted for Comanche Peak by Keeler & Long (Keeler & Long Report No. 06-0413) subjected failed phenoline 305 chips, with a CZ-11 inorganic zinc primer attached to the backside, to a simulated design basis accident (DBA) test in accordance with ASTM 3911. The result was that the almost all of the epoxy chips remained larger than 1/32 inch in diameter. The inorganic zinc failed in particulate form and disbonded from the coating chips.

Licensees may use this test report in conjunction with coating chip transport data to reduce the amount of degraded qualified epoxy coating debris. The data are not applicable to coatings in the ZOI since those coatings are expected to fail in particulate form due to erosion. They are only applicable to degraded qualified coatings outside of the ZOI that would be expected to fail by delamination in chip form. The data are not applicable to unqualified coatings.

5) Describe and provide bases for assumptions made in post-LOCA paint debris transport analysis.

The percentage of coatings debris that arrives at the sump strainer in the analysis should be provided. If less than 100 percent of the coating debris generated is analyzed to arrive at the strainer surface, the basis for settlement of the debris should be provided. The basis may be computational fluid dynamics (CFD) analysis, plant-specific transport testing, NRC-sponsored coating chip transport testing (NUREG/CR-6916), or some combination of these. If coatings debris is assumed to settle, a detailed description of the debris characteristics should be provided. The debris characteristics discussion should include the chip or particle size assumed and the basis for that assumption.

The coatings transport section of supplemental responses to GL 2004-02 does not need to include detailed transport analyses. Coatings transport information can be included in the transport portion of the supplemental response. Key assumptions on coating debris characteristics that are inputs to the transport analysis and the percentage of coatings that are assumed to transport to the strainer should be provided in the coatings section. Qualified coatings debris and unqualified coatings debris from inside the ZOI, degraded qualified coatings debris, and unqualified coatings debris may be described separately in this section as necessary.

6) Discuss suction strainer head loss testing performed as it relates to both qualified and unqualified coatings and what surrogate material was used to simulate coatings debris. Provide bases for the choice of surrogates.

This section should address the type of surrogate material used, the size range of surrogate coatings debris, and the density of the surrogate debris. A comparison of the surrogate debris characteristics to the actual coatings debris characteristics should be provided. Particle size, shape, and density are the parameters to focus on in this section. Licensees should show that their choice of surrogates conservatively represents the coating debris that is expected in a LOCA and the characteristics of the coatings debris assumed in the mechanistic analysis.